Ref. Ares(2018)6125139 - 29/11/2018

ZERO BRINE

D3.5: Report on the operation and optimization of the pilot system for the treatment of coal mine water (DRAFT)

November 2018

The ZERO BRINE project (www.zerobrine.eu) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730390.

Contents

Deliverable 3.5	Report on the operation and optimization of the pilot system for the treatment of coal mine water
Related Work Package	WP3 – Minimizing energy consumption and increase resource recovery yields through advanced treatment methods in the coal mine and textile industries
Deliverable lead	SUT
Author(s)	Krzysztof Mitko
Reviewer	
Contact(s)	Krzysztof Mitko
Grant Agreement Number	730390
Funding body(ies)	European Union's Horizon 2020 Framework Program
Start date	1-June-2017
Project duration	48 months
Type of Delivery (R, DEM, DEC, Other)[1]	DEM = Demonstrator
Dissemination Level (PU, CO, CI)[2]	PU = Public
Date last update	29 November 2018
Approved by	
Website	www.zerobrine.eu
Name of researcher(s) with roles	

Revision no	Date	Description	Author(s)
0.1	29/10/2018	First draft	Krzysztof Mitko (SUT)

The ZERO BRINE project has received funding from the European Commission under the Horizon 2020 programme, Grant Agreement no. 730390.

[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified

1. Introduction

Work Package 3 aims at demonstrating circular economy solutions in two process industry sectors: coal mining and textile industries. This includes two pilot plants, one in Poland and one in Turkey, showing innovative brine treatment at pilot scale. The pilot plant in Poland is an integrated membrane system, using waste (coal mine) water to produce raw materials, including sodium chloride, magnesium hydroxide, calcium chloride, clean water and gypsum – see Fig. 1.

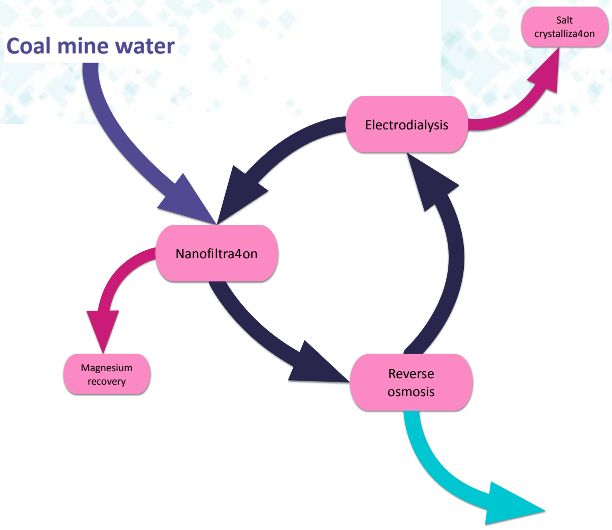

Fig. 1. General scheme of the proposed approach to coal mine water treatment

The plant is located in ZG "Bolesław Śmiały" in Poland – a coal mine owned by PGG (Polska Grupa Górnicza S.A.), the EU largest black coal mining company, producing annually approx. 30 million tons of black coal (total EU production: ~100 million tons). The "Bolesław Śmiały" coal mine currently discharges over 730 000 m^3 of saline coal mine water annually – see Tab. 1. Since the salinity of coal mine water surpasses the legal limits, they mix the waters with industrial waste water from the energy plant sharing the same site. There currently is no further treatment of discharge, but because of the tightening environmental regulations, the company is seeking new methods for decreasing the salt load in their waste waters. The technology proposed in the ZERO BRINE project has the surplus value of extracting valuable products from the discharge: reverse osmosis permeate of high purity, which can be utilized in a nearby power plant, and inorganic compounds such as magnesium hydroxide and salt, which have commercial value.

Tab. 1. The amount of waste water and salt load discharged by "Bolesław Śmiały" (data from 2017)

Volume of coal mine water [m^3]	Average concentration of chloride+sulfates in coal mine water [mg/dm^3]	Average concentration of chloride+sulfates in discharge after mixing with industrial waste water [mg/dm^3]	Environmental fees, assuming 1€ = 4.5 PLN [€]
730 897.0	12 999.5	2 114.0	77 828.20

To assess the plant performance, the results obtained in the ZERO BRINE project were compared with the reference technology (see Fig. 2): the desalination plant in Czerwionka-Leszczyny, Poland, formerly known as "Dębieńsko". The reference plant mixes saline mine water and reverse osmosis retentate from brackish water desalination. The brines are then concentrated with using vapor compression method, and next the evaporated salt and gypsum are crystallized. Evaporators are powered with electrical energy, what makes their exploitation expensive; the energy consumption of brine concentrator (VC) is 44 kWh/m^3 of distillate, while the energy consumption of brine crystallizer is 66 kWh/m^3 of distillate. One of the goals of ZERO BRINE project is to show that applying the circular economy principles can decrease the energy consumption by 50% compared to the reference plant.

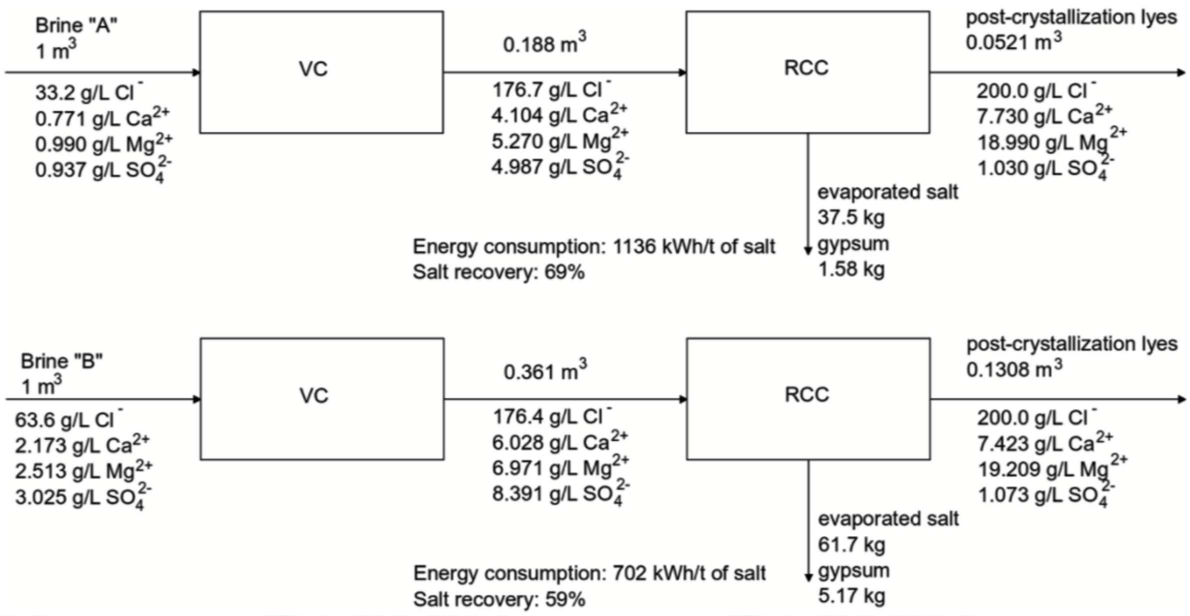

Fig. 2. The process stream compositions and performance indicators for "Dębieńsko" plant working on two different brines (VC – vapor compression, RCC – crystallizer), after Turek et al., Desalin. Water Treat. 64 (2017) 244-250

2. Technical design of the plant

(Under construction: short description of plant design and modifications we made during the run)

3. Description of experiments performed during plant run

a. Plant start-up

(Under construction: description of problems encountered during the start-up and changes with what we described in previous deliverables, if necessary)

b. Configuration 1

(Under construction: experiments when electrodialysis diluate is recycles before the nanofiltration)

c. Configuration 2

(Under construction: experiments when electrodialysis diluate is recycles before the reverse)

d. Salt crystallization

(Under construction: testing of eutectic freeze crystallizer)

e. Magnesium hydroxide crystallization

(Under construction: testing of UNIPA's crystallizer)

4. Optimization of process conditions

(Under construction: setting up empirical models describing the plant performance, optimization)

5. Comparison of energy consumption with reference plant

(Under construction: comparison with results we'll calculate for "Dębieńsko" technology)

6. Conclusions

(Under construction)